Advanced shearography kit and a robotic deployment platform for on-site inspection of wind turbine blades

Results in Brief

Robotic shearographic inspection of wind turbine blades for early fault detection

While wind turbines are key to the production of green energy, significantly contributing to all renewable electricity, blades can be damaged by the very forces that power them. Keeping them competitively functioning requires proper inspection and maintenance.

There are around 3 800 wind turbine blade failures annually, with many attributed to poor maintenance, some involving human injury and fatality. When it comes to checking wind turbine blades for damage and defects, close inspections are necessary. The options for achieving this are usually either to dismantle the blade for transportation to a workshop or to send trained inspectors to check in situ using ropes, pulleys and harnesses. Both involve significant production downtime.

With the EU’s Innovation Action support, the WInspector project developed a robotic platform which climbs up wind turbine towers to deploy a shearography kit.
Close inspection of structural integrity

The principal problems with current methods for wind turbine blade inspection are twofold. Firstly, reliance on at least one person to work at height using a rope for manoeuvrability is highly risky. Secondly, it is also inefficient, as visual inspection only identifies superficial defects.

While there are solutions which use specially designed platforms to enable better access to the blade under investigation, they either are typically not sufficiently agile or cannot get close enough for a high-quality non-destructive testing technique to be used. Hence, platforms are normally used for visual inspections only.

WInspector’s robotic inspection system, which reaches the blade to attach an advanced inspection unit, is controlled remotely by the operators on the ground, increasing both safety and efficiency. “Getting the shearography system to stay on the blade with sufficient stability for inspection, was the hardest task. We had multiple rounds of design and test, before finally reaching a workable solution,” says project coordinator Mr Jan Seton.

The shearography method used can detect sub-surface defects (such as cracks, delamination, disband and impact damage) by measuring the deformation (in the form of a fringe pattern) of the target object under stressing (mechanical stressing or thermal stressing by a heat gun). With no defect, the deformation is usually uniform or smooth, so the fringe pattern appears regular. When there is a sub-surface defect, the deformation will show stress concentration at the location of the defect indicated by an irregular fringe pattern.

The principal advantages of shearography are the relatively large area it can cover in a single inspection and that it only detects those defects affecting structural integrity, avoiding false alarms triggered by cosmetic scratches, etc.

Increased safety and efficiency

As well as contributing to the EU’s renewable energy and climate objectives, WInspector also strengthens the business case for the wind energy sector by potentially reducing overall costs (due to late repair and production downtime) for a wind farm.

Earlier this year, the team conducted two field trials at the CRES (Centre for Renewable Energy Sources) wind farm in Lavrion, Greece. These were able to produce shearographic fringe patterns after processing the laser speckle images recorded using a shearing image interferometer included in the digital camera. “To
our knowledge, our successful field trials are the first time in the world that shearography fringe patterns have been obtained from on-site inspection of a wind turbine tower, proving that our system and strategy work,” says Seton.

Currently, the team is fine-tuning the technology, concentrating especially on increased inspection speed and further optimisation of the image processing algorithms. They anticipate the technique being available to the market within 3 to 5 years.

**Keywords**

WInspector, renewables, wind, turbine, blade, inspection, robot, shearography, fringe patterns, non-destructive testing, algorithms

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**Project Information**

**WInspector**

Grant agreement ID: 700986

DOI

10.3030/700986

Closed project

Funded under

H2020-EC

H2020-EU.3.

H2020-EU.2.

**Overall budget**

€ 2 750 193,39

**EU contribution**

€ 2 317 939,63

**Start date**

1 March 2016

**End date**

31 May 2019

**Coordinated by**

WRS MARINE INSPECTIONS AND SERVICES BV

Netherlands

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